

## **REMARKS/ARGUMENTS**

The claims have been amended to more clearly and succinctly recite the present invention. Claim 1 has been amended to recite in the preamble:

“A bio-fuel system for concurrent production of electrical power and single cell protein and consumption of carbon dioxide (CO<sub>2</sub>),”

which is supported in several places in the specification including at the bottom of page 8, lines 31 to 34, page 12, lines 13 to 29, and page 14, lines 1 to 23, and page 14, lines 33 to page 15, line 10.

The phrase:

“a) a fuel cell including”

has been deleted as it may be misleading. The system disclosed herein and being recited in claim 1 is not a combination of a “fuel cell” per se and “bioreactor” but includes a “bioreactor” and a structure which is not strictly a “fuel cell” due to the fact that a low temperature “fuel cell” includes a catalyst, usually a precious metal such as platinum on the cathode. The present invention avoids the need for precious metal catalysts at the cathode and exhibits efficiencies of 80% compared to known “fuel cells” which exhibit efficiencies between 30 and 50%, see page 14, lines 27-30.

Claim 1 has been amended to recite:

“a first means for injecting with a fuel having a hydrogen constituent.. “

which is consistent with the terminology used on page 14, line 20. A similar amendment has been made in the paragraph reciting the bioreactor.

Claim 1 has been amended to recite in the anode compartment the half cell reaction:

“a reaction at the anode electrode being electrochemical oxidation of at least the hydrogen constituent of the fuel to produce ...”

because, if the fuel is pure hydrogen gas, only hydrogen is oxidized, but if the fuel contains other constituents, such as carbon, then they will be oxidized as well, see lines 1 to 7 on page 17 of the specification

The portion of claim 1 reciting the bioreactor has been amended to incorporate the subject matter of claim 4, and the subject matter of claim 16 has been incorporated into claim 1. Claims 4 and 16 have been cancelled from the application.

The Examiner has rejected claims 17, 18 and 19 under 35 U.S.C. 112, first paragraph, as being on the basis of lack of enablement in the description. Applicants

respectfully request withdrawal of this rejection for the following reasons. Claim 17 has been amended to delete the phrase “voltage control” so the claim recites:

“means for applying and controlling a voltage on the cathode electrode...”.

This is fully supported on page 15, lines 8 to 10. Similarly, claims 18 and 19 have been amended to delete the phrase “reagent control” to simply recite a means for doing controlling the Fe ion ratio or cultivation conditions. Applicants respectfully submit that those of ordinary skill in the art would have no difficulty in understanding these features, whether controlling the ratio of the iron ions or controlling concentrations of the dissolved nutrients concentrations as recited in claims 17 to 19, and also clearly disclosed on page 9, lines 1 to 4.

Applicants respectfully submit that those skilled in the art would readily appreciate that there are numerous ways in which this could be done and those skilled in the arts do not need to be given specific details regarding power supplies or reagent manifolds for varying voltages on the cathode or varying concentrations of various reagents. Applicants respectfully submit that those of ordinary skill in the art, upon reading the cited passages above, would not, under any circumstances, need to engage in “undue experimentation” to implement the recited limitations. Thus applicants believe they are fully entitled to claim these limitations as broadly as possible by using the means plus function language. The specification has been amended to insert claims 17 to 19 directly into the Detailed Description on page 15, line 10.

### **Patentability over the Cited References**

The Examiner has rejected claims 1, 2, 4 to 9, 15 and 16 under 35 U.S.C. 103(a) as being anticipated by Tsunoda (EP 62,256,382) et al. The Applicants respectfully request the Examiner to withdraw the rejection in view of the following remarks.

On November 12, 2008, Applicant/inventor Dimitre Karamanev, his Canadian patent counsel Lynn C. Schumacher and US patent counsel Alyssa Finamore and Ralph Dowell met with Examiner Bryant Suitte and Primary Examiner Dah-Wei D. Yuan at 2:00 PM. Applicant and his patent counsel would like to thank Examiners Suitte and Yuan for taking the time to meet with them.

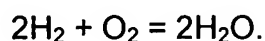
During the interview, the parties discussed the differences between the apparatus of claim 1 and the cited reference to Tsunoda. It was discussed that present claim 1 recites an anode compartment in which the anode reaction is oxidation of a hydrogen containing fuel while in Tsunoda the anode reaction is oxidation of  $\text{Cr}^{+2}$  to  $\text{Cr}^{+3}$  and thus on this basis claim 1 recites subject matter which is not disclosed in Tsunoda.

Applicants have carefully reviewed Tsunoda and find no disclosure that teaches or discloses the subject matter of claim 1. Tsunoda is directed to a redox cell having an anode reaction given by  $\text{Cr}^{+2} \rightarrow \text{Cr}^{+3} + \text{e}$ , and a cathode reaction given by  $\text{Fe}^{+3} + \text{e} \rightarrow \text{Fe}^{+2}$ .

On page 4, lines 6-7 and on page 5 end of the second paragraph of the Examiner's report the Examiner states that hydrogen is supplied to the negative electrode chamber 7 where production of protons occurs and asserts that the overall redox reaction is oxidation of oxygen gas to water. Applicant respectfully disagrees and notes that the description and figure in Tsunoda disclose and show hydrogen injected into the tank 9 where regeneration (reduction) of the Cr ions takes place as disclosed on page 4, lines 3 to 5, which also requires a photocatalyst, see the figure also which shows gas stream 12 (hydrogen) injected into tank 9 where regeneration of the Cr ions takes place. Further, the Examiner's attention is directed to page 2 of Tsunoda where it is disclosed that that the overall reaction is:



Further, the overall reaction in the present device, when for example the hydrogen containing fuel is pure hydrogen gas, is



Thus, Tsunoda is a pure redox cell with a bioregeneration of the iron ions and an anode at which reaction of the chromium ions occurs and photoregeneration of the chromium ions is performed in a separate regeneration tank. In contrast, the present device of claim 1 includes an gas anode at which a hydrogen containing fuel is oxidized.

The Examiner has rejected claim 3 under 35 U.S.C. 103(a) as being unpatentable over Tsunoda (EP 62,256,382) as applied to claims 1, 2, 4 to 9, 15 and 16 above, and further in view of Ritts et al. (U.S. Patent Pub. No. 2003/0049511). Applicant respectfully requests the Examiner to withdraw the rejection in view of the above noted discussion of the differences between Tsunoda and claim 1. Further, Ritts discloses membranes, but there is no teaching of a bioreactor combined with an anode using hydrogen, but does not, in combination with Tsunoda, disclose the subject matter of claims 1, 2, 4 to 9, 15 and 16. Responsively, Applicant respectfully requests withdrawal of this rejection.

The Examiner has rejected claims 10-14 under 35 U.S.C. 103(a) as being unpatentable over Tsunoda (EP 62,256,382) as applied to claims , 2, 4 to 9, 15 and 16 above, and further in view of Heller et al. (U.S. Patent Pub. No. 2003/0044721). Applicant respectfully requests the Examiner to withdraw the rejection in view of the above noted discussion of the differences between Tsunoda and claim 1. Further, Heller discloses carbon electrodes coated with catalysts, but does not, in combination with Tsunoda, disclose the subject matter of claims 10 to 14. Responsively, Applicant respectfully requests withdrawal of this rejection.

In addition, Applicants review of the three (3) cited references indicates the subject matter of claims 17 to 19 is not disclosed in any of these references.

In order to overcome the limitation of classical fuel cells, Applicants have combined a fuel cell anode and a carbon-based redox flow cell cathode, separated by a membrane permeable by hydrogen ions. Applicants respectfully submit that this combination is completely new and inventive as evidenced by the fact that, as disclosed on page 14, lines 24 to 32, the biofuel cell system of claims 1 to 19, very unexpectedly gives efficiencies in the range of 80% to 90%, much higher than that achievable with typical fuel cells, which are below 50%. There is nothing in the field of bioreactors or pure fuel cells that Applicant is aware of that suggests this combination, nor predicts such a surprisingly efficient system. As best understood by Applicant, the system of Tsunoda, which does not appear to have been implemented, could not come close to these results due to the low efficiencies involved with regenerating the chromium ions and the power needed to separate the microbes from the "reproduced positive electrolyte" prior to returning the latter to tank 5 (as disclosed on page 4, line 12 to 16, would consume more power than could be produced by the system.

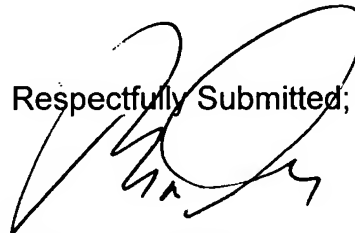
In addition, there is no other known electricity generation system of any kind which consumes CO<sub>2</sub> during electricity generation. There is also no other known electricity generation system which produces single cell protein as a co-product. The former feature is of great importance from environmental point of view, while the latter is very important from the point of view of producing animal feedstock.

In view of the foregoing comments on the differences between the present claims and the cited references, Applicants respectfully submit the present claims recite

patentably distinct subject matter and request withdrawal of all the rejections. An earnest effort has been made to place this application in condition for allowance which action is respectfully solicited.

Should the Examiner have any questions concerning this amendment and response, it would be appreciated if the Examiner would contact the undersigned attorney-of-record at the telephone number shown below for further expediting the prosecution of the application.

Respectfully Submitted;

A handwritten signature in black ink, appearing to be 'R. A. Dowell', written over the typed name.

Ralph A. Dowell  
Reg. No. 26,868

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Dowell & Dowell, P.C.  
2111 Eisenhower Ave.  
Suite 406  
Alexandria, Va. 22314  
Tele: 703-415-2555  
e-mail: [dowell@dowellpc.com](mailto:dowell@dowellpc.com)  
Customer Number: 000293